Appendix M
Scientific Plan for Dry Cargo Sweepings Impact Analysis

U.S. Department of Transportation

Research and Innovative Technology Administration

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TECHNICAL MEMORANDUM

SCIENTIFIC PLAN FOR DRY CARGO SWEEPINGS IMPACT ANALYSIS

Prepared for

U.S. COAST GUARD

Prepared by

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Introduction

An approach to scientifically evaluate the impacts of past, ongoing and potential future dry cargo sweeping practices in the Great Lakes was presented on May 30, 2006. This technical memorandum presents the methods, analytical techniques, scope, and schedule for the recommended approach. The plan only addresses the scientific aspects of the approach and thus does not elaborate on other portions (i.e. Task 1, Expert Committee and Task 2, Literature Review). The Scientific Plan is intended to be comprehensive, but not detailed, thus it does not provide the level of detail found in a Work Plan.

The steps in the proposed investigation were presented in the approach as individual tasks, and are also presented to describe the Scientific Plan.

Materials and Methods

Task 3: Sweepings Characterization

The physical, chemical, and toxicological characteristics of the dry cargo sweepings will be defined in order to determine their fate and impacts. Four types of dry cargo residue slurry (iron, coal, limestone, and an additional residue with potential impacts) will be collected from a typical cargo vessel sump. The slurry will be analyzed chemically and physically for heavy metals, inorganics, SVOCs, VOCs, total organic carbon, specific gravity, and phosphorous using methods for analysis of water to represent conditions in the water column. Slurry will also be analyzed toxicologically for effects on fathead minnow and *Daphnia magna*. Slurry samples will be de-watered to obtain dry tailing samples that will be similarly analyzed. If possible the sample will be collected from a ship's sump similar to collecting a sediment sample. If this is not possible, the slurry will be gravity thickened to simulate moisture content of typical Great Lakes sediment. Dry tailings will be analyzed chemically and physically for heavy metals, inorganics, SVOCs, VOCs, biological oxygen demand, chemical oxygen demand, total organic carbon, grain size, and specific gravity using methods for analysis of sediments. Dry tailings will be analyzed toxicologically for effects on amphipods and chironomids. The number of samples and analytical methodology are presented in Table 1.

Task 4: Sweepings Discharge Analysis

The sweepings discharge analysis will utilize focused mathematical modeling to simulate water quality impacts and deposition rates to make scientific conclusions. The relative impact of the sweepings will depend upon many factors, including: type of sweeping material, discharge location (shallow waters, connecting waters, or deep waters), substrate type, and others. Furthermore, the type of mathematical model(s) most appropriate for the analysis depends upon whether the sweepings have the opportunity to significantly affect the water column water quality, the substrate, water quality through chemical reaction, or a combination of these opportunities. The number of possible combinations of material, location, substrate type, etc., is extensive. Consequently, the analysis should be prioritized based upon the comprehensive information gathered on sweepings locations, materials, etc. during previous tasks. Following this approach will focus the modeling analysis towards areas where actual impacts may be occurring.

Based upon this approach, the scientific sweepings discharge analysis should include the following elements:

1. Potential impact screening from prior tasks
2. Model screening
3. Model selection(s)
4. Model application

Potential sweepings impact screening from prior tasks

Information gathered from prior tasks will be crucial to assessing where potential environmental impacts from sweepings may occur and to focus the modeling analysis upon those areas. The information from previous tasks will be viewed in the context of modeling analysis to answer questions such as:

- What modeling is needed in light of where the sweepings occur?
- How deep is the water where sweepings occur?
- What models can simulate the quantity of material discharged?
- Should the sweepings material size distribution influence model selection?
- What chemical constituents may be important?
- When are chemical constituents important (in the water column during discharge, in the sediments, etc.)?
- What information is readily available and what additional information is needed to conduct modeling?

The result of impact screening from prior tasks will be a list of minimum modeling requirements based upon a strategic analysis of the comprehensive information available on sweepings materials, locations, quantities, and other information gathered in prior tasks. This information will then be combined with the model screening results to select appropriate model(s).

Model screening

Model screening is important because there are many potential situations in which sweepings discharges occur. The model screening will focus upon identifying model strengths and weaknesses for the variety of potential conditions where analysis may be needed. The screening should include a matrix listing the applicability of the model to provide scientific answers to sweepings for areas such as:

- Connecting channels
- Shallow water
- Deep water
- Water column water quality
- Lake bottom impacts

- Ability to simulate conservative pollutants
- Material deposition rate prediction
- Capability to simulate a distribution in particle size
- Data input needs and calibration requirements
- Model resolution
- Hydraulic Complexity (e.g., one versus three dimensional)
- Model ease of use
- Model availability and cost (public domain versus proprietary)
- Model acceptability and application history in the U.S. and/or Canada

The identified models will be ranked in their capability to meet each of these and other important factors identified by the Coast Guard, the project team, or others as appropriate. The model screening will at a minimum include models that simulate discharges into water, estimate material deposition, calculate material dilution, and estimate lake bottom impacts. The modeling effort will provide feedback to data collection tasks on potential material specific data needs, such as grain size distribution, that models may require.

The result of the model screening will be a matrix ranking the different models in their ability to provide answers for situations where modeling may be needed. It is expected that more than one model may end up being selected and that the model screening results will point towards the most appropriate models for the scientific analysis.

Model Selection(s)

Based upon the model screening assessment and information gained from prior tasks, the most appropriate model(s) will be selected. A modeling approach discussion with the Coast Guard and other appropriate project team members will occur and the modeling will begin. In general, the simplest model(s) that satisfy the objectives of the scientific analyses would be selected. These could range from simple spreadsheet calculations for certain processes to more complex computerized fate, transport, and effects model(s).

Model Application

The sweepings discharge modeling analysis will make use of information gathered in other tasks and is expected to include data from: the characterization as determined in Tasks 2 and 3; representative surface water characterization (i.e., temperature, depth, etc.) as determined from the literature; and rate of discharge and vessel movement determined from industry-provided information.

Model calibration or validation requirements will be identified in the model screening and selection elements above. This may range from simply documenting that the concepts and equations used are appropriate to using actual characterization data to validate model predictions.

Scenario modeling will make estimations of future impacts using current practices and if appropriate, future impacts based upon alternative practices developed as part of the NEPA process. The model application will focus upon the materials and locations frequently associated with sweepings and the potential for water column or sediment impacts.

Task 5: Historic Deposition Analysis

The objective of the Historic Deposition Analysis is to identify areas within the Great Lakes which receive substantial discharge of and potentially high relative impact from dry cargo sweepings. The physical characteristics, chemical characteristics, biological characteristics, and associated impacts for these areas will be investigated in subsequent tasks. The identification will be accomplished in three steps:

- From historic analysis of sweepings discharge, designate the trackline segments (i.e. portions of shipping lanes with defined dry cargo sweeping discharge activity) with the greatest discharge rates and potential impacts,
- From the comprehensive literature review (Task 2) determine if there are other factors (e.g. impacts from other sources, sensitive biological resources, etc.) that render segments on the list of potentially impacted trackline segments (identified in the above step) more or less appropriate for detailed deposition analysis,
- Conduct field reconnaissance and large scale mapping of selected trackline segments to identify the specific sampling locations.

This scientific plan accomplishes the first of the three steps. The document *A Study of Dry Cargo Residue Discharges in the Great Lakes* prepared for the USCG by Potomac Management Group (2003) was reviewed to determine the estimated sweepings discharge rate and relative impacts in each trackline segment of the Great Lakes (findings summarized in Table 2 and tracklines shown in Figures 1 through 4). Based on this analysis, nine tracklines were identified as potential areas for detailed investigation. Of these nine tracklines, the following four were targeted as having the greatest sweeping discharge (on a lb per acre basis) and highest potential for impact for one or more sweepings type (Table 2). These four tracklines are the following:

- E (for Lake Erie) FE-1
- EO
- M (for Lake Michigan) S-1
- S (for Lake Superior) SWT

In addition the following five trackline segments were identified as alternate sites:

- EE
- EW-1
- H (for Lake Huron) N-1
- MS-2
- SET-1

All nine of these tracklines will be further evaluated in as described below and the most appropriate tracklines will be carried forward for additional analysis.

Detailed bottom profiling of selected tracklines will be made using appropriate technology such as side scan sonar or equivalent techniques to identify areas of intense sweepings deposition. The detailed bottom profiling includes confirmation bottom photographs and material samples to verify and calibrate the electronic scans. Real-time data visualization during the data collection process should be used to note locations for verification photographs, samples, and other potential notable features. Acoustic discontinuities should be noted and minimized using appropriate procedures.

Data interpretation will be conducted to characterize geophysical bottom materials and areas of dry cargo sweepings deposition. All bottom profiling, confirmation photographs, material samples, and any other pertinent information should be georeferenced and made available for the ARC-GIS platform.

The information gathered on the lake bottom from side detailed bottom profiling will define the geophysical characteristics (e.g. dunes, cobbles, boulders, clays, etc.) present at each site. The geophysical characterization will then be used to make qualitative assessments of the potential affects of sweepings deposition.

Bottom profiling data collection will be coordinated with other data collection activities to optimize the identification and locations of the data collection efforts.

Task 6: Physical Characterization of Deposition Areas

The physical character of the material in four dry cargo sweepings deposition trackline areas (selected in Task 5) will be determined for bulk sediment samples collected with a Smith-McIntyre or similar. Samples will be analyzed for grain size, density moisture content, depth of deposition (based on a visual estimate), biologically active zone (based on a visual estimate), and degree of mixing (based on a visual estimate). The number of samples and analytical methodology are presented in Table 1.

Task 7: Chemical Characterization of Deposition Areas

Analysis for those constituents that were detected in the chemical analysis described in Task 3 will be conducted from bulk sediment samples collected in four dry cargo sweepings deposition trackline areas. In addition, pore water will be extracted from sediment and similarly analyzed for constituents detected in Task 3. Demersal and epibenthic organisms will be collected using traps or trawls and analyzed for only those bioaccumulative metals, SVOCs, and VOCs, as identified in Table 4-2 of U.S. Environmental Protection Agency (2000) "*Bioaccumulation testing and interpretation for the purpose of sediment quality assessment - status and needs*," that were detected in Task 3. The number of samples and analytical methodology are presented in Table 1.

Task 8: Biological Characterization of Deposition Areas

The biological characteristics of the deposited dry cargo sweepings will be investigated using several methods described below. The number of samples and analytical methodology associated with each subtask are presented in Table 1.

Task 8.1: Toxicity Testing

Bulk sediment samples will also be analyzed toxicologically for effects on amphipods and chironomids using standard EPA and ASTM methodology (similarly to the analyses described above for the dry cargo sweepings). If elevated concentrations of constituents are observed in pore water samples analyzed as part of Task 7, the pore water will be analyzed toxicologically for effects on fathead minnow and *Daphnia magna* using standard EPA methodology.

Task 8.2: Benthic Community Structure Analysis

Samples from the same locations selected for Chemical Analysis (Task 7) and Toxicity Testing (Task 8.1) will be collected from the bottom substrate material using a Smith-McIntyre or similar. Collected material will be sieved through a standard No. 30 (0.595-mm mesh openings) sieve to remove silt and fine sands and consolidate the sample for processing. Benthic macroinvertebrate samples will be identified to the lowest practical level depending on the project objectives. Data will be analyzed by comparing test samples and those from the reference location and the literature using selected metrics. Each sample metric outside the reference range will be noted.

Procedures used for the assessment of the Great Lakes will be based on the classification of the environment into physical (substrate composition, water depth) as well as geographic (harbor, open water) characteristics. The classifications reduce the array of physical and geographic characteristics to the smallest number of classes that represent comparable biological communities. Previous studies of the Great Lakes will be reviewed to determine the primarily physical and geographical characteristics. In addition, a reference condition will be established for each test location.

Task 8.3: Benthic Community Colonization Investigation

In situ biomonitoring methods are best suited to the task of assessing long-term impacts. These methods employ indigenous biota as indicators of the health and well being of the receiving water. Many of the organisms have relatively long life cycles and therefore integrate local conditions over time. Much is known about the tolerance of these organisms to different environmental stressors, thus reflecting potential causes of impact.

The objective of this assessment method is to determine if dry tailings have the potential to cause long-term impacts to lake biota, using indigenous organisms as indicators for impact assessment. To meet this objective, three trays (approximately 2 meters in diameter) will be deployed to bottom sediment to act as artificial substrates for colonization. Two trays will be divided into 4 quadrants containing each of two types of dry tailing at 100% concentration or 50% concentration (thus 2 trays with 2 types of tailings each). Dry tailings at 50% concentration will be mixed with naturalized sterile (via freezing) sediment to achieve the desired dilution. The third tray will contain 100% naturalized sterile sediment. Following an adequate time period, estimated at 3 to 6 months, the trays will be retrieved or subsampled depending on logistics, and the collected material from each quadrant will be sieved through No. 30 (0.595-mm mesh openings) sieve to remove silt and fine sands and consolidate the sample for processing. Benthic macroinvertebrate samples identified to the lowest practical level.

Task 8.4: Nutrient Enrichment Investigation

Standard algal growth stimulation assays will be used to assess the effects of dry cargo sweepings on Great Lakes phytoplankton communities. Tests will be conducted for each type of cargo using the basic approach of creating dry cargo slurry with lake water and testing the supernatant water for potential effects on the natural algal community. The supernatant water (stock solution) will be thoroughly tested for nutrient and other chemical content.

Lake water and a composite of the natural lake phytoplankton community will be freshly collected for each test. Tests will be conducted during the summer period of thermally-stratified lake conditions. At each station designated for testing, water column profiles of temperature and dissolved oxygen will be measured using calibrated field meters. From the profiles, the epilimnion will be identified and three discrete samples will be collected that are designed to span the upper, mixed layer. Secchi disk depth will be measured as a surrogate for light penetration and measure of water clarity. Water from the three sampled depths will be mixed to provide a composite epilimnion sample with composited phytoplankton assemblage. A subsample of several liters of the composited water will be mixed with a known weight of dry cargo material, mixed as slurry, and settled for approximately 2 hours (time to be adjusted based on discharge modeling results). The supernatant from that slurry will provide the stock water to be used in the bioassays.

The bioassays will consist of triplicate samples of four conditions (12 containers total for any one experiment). The four conditions will be:

- 100% stock water
- 50% stock water, 50% composite lake water
- 10% stock water, 90% composite lake water
- 100% composite lake water (control)

All conditions will contain approximately the same initial inoculate of lake phytoplankton because the stock and composite solutions will have been created from the same combined composite epilimnion water.

Each sample will consist of 1 liter of water in glass flasks, lightly bubbled with an air line to gently circulate and aerate the phytoplankton mix. Triplicate initial stock water and composite lake water samples will be collected at the start of the experiment. The experimental samples will then be incubated in a growth chamber at conditions designed to mimic field conditions at the time of collection (mid-epilimnion temperature and midday light) on a 14 hours light: 10 hours dark cycle. The incubation will proceed for 4 days. At the end of the incubation, water will be collected from each flask for chlorophyll a analysis and a separate subset collected and preserved in Lugols solution for species identification and cell counts. The results for chlorophyll and subsets or various combinations of cell count results can then be analyzed using a basic 3 x 4 regression design to test for significance of difference among conditions and for differences between experimental and control conditions.

The final test results for any one station/time and cargo material will consist of 6 initial and 12 final, experimental samples for both chlorophyll a and cell counts.

Schedule for Completion

The assets required and schedules for task completion are provided in Table 3 and Figure 5, respectively.

Tables

Table 1. Summary of Proposed Data Sampling for Dry Cargo Sweepings Impact Analysis

Task/Subtask	Type/Matrix	Sample Locations	Number of Samples	Collection Method	Analysis
Task 3: Sweepings Characterization	Dry tailings (iron, coal, limestone, to be determined)	Samples will be collected or provided from typical cargo sump in 8 different vessels	3 samples from different areas of each of 2 vessels for each sweeping type (4 types) = 24 samples (Note: for toxicological analyses, the 3 samples will be composited)	Slurry samples will be de-watered by centrifuge (10,000 x g for 30 mins) and solids will be used for analysis	Heavy Metals and Inorganics (EPA Method), TCL SVOCs and VOCs (OLMO4.2), Biological Oxygen Demand (EPA Method 405.1), Chemical Oxygen Demand (EPA Method 410.4), Total Organic Carbon (9060), Grain Size (ASTM D422-63); Specific Gravity
					Hyallella azteca (amphipod) 28-day survival and growth (ASTM)
					Chironomus tentans (Chironomid) 10-day survival and growth (EPA 600/R-99/064)
	Slurry (iron, coal, limestone, to be determined)	Samples will be collected or provided from typical cargo sump in 8 different vessels	3 samples from different areas of each of 2 vessels for each sweeping type (4 types) = 24 samples (Note: for toxicological analyses, the 3 samples will be composited)	Grab sample from cargo sump	Total and Dissolved Heavy Metals and Inorganics (EPA Method), TCL SVOCs and VOCs (OLMO4.2), Total Organic Carbon (9060), Specific Gravity, Phosphorous (365.2)
					Pimephales promelas (fathead minnow) 7-day survival and growth embryo-larval test (EPA/600-4-91/002)
					Daphnia Magna (claderceran) 7-day survival, growth, and reproduction (EPA/600/D-87/080)
Task 6: Physical Characterization of Deposition Areas	Sediment	4 depositional tracklines and 2 reference areas	1 sample from each of 4 depositional tracklines and 2 reference areas = 6 samples	Bulk grab using Smith-McIntyre or similar; 5-pt composite per grab	Grain size (ASTM D422-63), Density moisture content, Visual estimate of depth of deposition, Visual estimate of biologically active zone, Visual estimate of degree of mixing
Task 7: Chemical Characterization of Deposition Areas	Sediment	4 depositional tracklines and 2 reference areas	1 sample from each of 4 depositional tracklines and 2 reference areas = 6 samples	Bulk grab using Smith-McIntyre or similar; 5-pt composite per grab	Analytical methods for only those compounds detected in Task 3 (Sweeping Characterization)
	Pore water	4 depositional tracklines and 2 reference areas	1 sample from each of 4 depositional tracklines and 2 reference areas = 6 samples	Bulk grab using Smith-McIntyre or similar; Ex-situ pore water extraction using centrifuge (10,000 x g for 30 mins)	Analytical methods for only those compounds detected in Task 3 (Sweeping Characterization)
	Epibenthic or Demersal tissue	4 depositional tracklines and 2 reference areas	1 sample from each of 4 depositional tracklines and 2 reference areas = 6 samples	Traps or troll	Analytical methods for only those bioaccumulative compounds detected in Task 3 (Sweeping Characterization)
Task 8.1: Biological Characterization of Deposition Areas					
Task 8.1: Toxicity Testing	Sediment	4 depositional tracklines and 2 reference areas	1 sample from each of 4 depositional tracklines and 2 reference areas = 6 samples	Bulk grab using Smith-McIntyre or similar; 5-pt composite per grab	*Hyallella azteca* (amphipod) 28-day survival and growth (ASTM) *Chironomus tentans* (Chironomid) 10-day survival and growth (EPA 600/R-99/064)
	Pore water (performed only if elevated chemical concentrations are observed in Task 7)	4 depositional tracklines and 2 reference areas	1 sample from each of 4 depositional tracklines and 2 reference areas = 6 samples	Bulk grab using Smith-McIntyre; Pore water extraction	*Pimephales promelas* (fathead minnow) 7-day survival and growth embryo-larval test (EPA/600-4-91/002) *Daphnia magna* (Claderceran) 7-day survival, growth, and reproduction (EPA/600/D-87/080)
Task 8.2: Benthic Community Structure Analysis	Benthic macroinvertebrates	4 depositional tracklines and 2 reference areas	1 sample from each of 4 depositional tracklines and 2 reference areas = 6 samples	Bulk grab using Smith-McIntyre or similar	Collected material sieved through No. 30 (0.595-mm mesh openings) sieve to remove silt and fine sands and consolidate the sample for processing. Benthic macroinvertebrate samples identified to the lowest practical level.
Task 8.3: Benthic Community Colonization Investigation	Artificial substrate (tray) divided into 4 quadrants containing 100% tailings, 50% tailings, or 100% naturalized sterile sediment	3 trays in a suitably unaffected area to be determined based on logistics	4 samples from each of 4 quadrants per tray = 48 samples	Deployment and retrieval	Collected material sieved through No. 30 (0.595-mm mesh openings) sieve to remove silt and fine sands and consolidate the sample for processing. Benthic macroinvertebrate samples identified to the lowest practical level.
Task 8.4: Nutrient Enrichment Investigation	Slurry (iron, coal, limestone, to be determined) mixed with lake water and a composite of the natural lake phytoplankton community	Slurry samples will be collected or provided from typical cargo sump in 8 different vessels	Triplicate samples of four conditions (12 containers) for each of 2 composited slurry types (4 types) = 96 samples	Slurry collected from cargo sump; lake water from three sampled depths to provide a composite epilimnion sample with composited phytoplankton assemblage	Initial and final chlorophyll a analysis, species identification and cell counts

Table 2. Normalized[1] Dry Cargo Sweepings Input to Great Lakes Trackline Segments																	
	Iron		Coal		Stone		Grain		Salt		Coke		Slag		Total		
Trackline Segment	lb / acre	Rel. Impact	lb / acre	Rel. Impact	lb / acre	Rel. Impact	lb / acre	Rel. Impact	lb / acre	Rel. Impact	lb / acre	Rel. Impact	lb / acre	Rel. Impact	lb / acre	Rel. Impact	Prospective Sample
EE	6.24	0.81	12.44	0.85	1.40	0.78	2.70	0.74	11.33	0.86	1.83	0.70	0.00	0.44	6.58	0.79	
EFE-1	4.52	0.91	35.58	1.90	0.00	0.39	28.10	1.66	82.00	1.29	39.00	1.57	0.00	0.66	14.68	1.33	
EFE-2	0.31	0.41	2.47	0.63	0.00	0.26	2.00	0.74	5.67	0.58	2.67	0.70	0.00	0.44	1.02	0.55	
EO	3.46	1.52	3.63	1.59	18.36	3.25	7.40	1.85	8.22	1.44	12.33	1.74	0.00	1.10	7.80	1.73	
EW-1	5.40	1.22	10.30	1.69	5.45	1.56	18.60	2.22	15.89	1.73	9.50	1.39	5.75	1.76	7.39	1.63	
EW-2	4.16	1.22	7.92	1.27	4.19	1.56	14.30	2.22	12.22	1.73	7.33	1.39	4.50	1.76	5.68	1.51	
HC	0.32	0.41	0.72	0.42	2.47	0.72	0.70	0.37	0.56	0.39	0.67	0.40	1.75	0.50	1.04	0.44	
HN-1	1.50	1.52	1.11	1.59	1.95	1.81	1.60	1.85	1.56	1.95	5.33	1.99	0.00	1.26	1.55	1.68	
HN-2	1.40	0.30	1.04	0.32	1.82	0.36	1.50	0.37	1.56	0.39	5.00	0.40	0.00	0.25	1.46	0.34	
CS-1	1.85	0.91	1.75	0.95	2.85	1.09	0.40	0.55	1.67	1.17	0.00	0.60	0.00	0.76	2.01	0.88	
HS-2	1.68	0.61	1.58	0.63	2.59	0.72	0.40	0.37	1.44	0.78	0.00	0.40	0.00	0.50	1.82	0.59	
MCE	4.83	0.61	3.12	0.63	4.31	0.67	0.60	0.37	1.67	0.78	7.17	0.70	23.50	0.88	4.25	0.62	
MCW	1.83	0.91	1.69	0.95	0.59	0.67	0.00	0.55	1.33	1.17	0.00	0.52	0.00	0.66	1.36	0.83	
MN-1	2.40	1.52	4.65	1.59	10.62	2.23	0.00	0.92	2.00	1.95	2.33	1.74	6.75	2.21	5.21	1.60	
MN-2	0.35	0.76	0.68	1.06	1.56	1.67	0.00	0.92	0.33	0.97	0.33	0.87	1.00	1.10	0.76	1.00	
MS-1	2.22	3.04	3.59	1.59	12.67	2.23	0.50	1.85	0.00	0.97	35.00	2.61	17.00	2.21	5.93	2.10	
MS-2	12.58	0.51	2.03	0.32	7.18	0.33	3.10	0.37	0.00	0.19	19.83	0.52	9.50	0.44	7.75	0.38	
ONT	0.68	0.86	0.93	0.95	0.00	0.36	7.00	1.11	7.89	1.17	7.17	1.19	12.25	1.51	1.07	0.97	
SC	0.30	0.81	0.18	0.85	0.02	0.45	0.50	0.74	0.56	0.78	0.00	0.80	0.00	1.01	0.19	0.78	
SEO	1.01	1.52	0.27	1.06	0.04	0.56	0.00	0.92	0.00	0.97	0.33	0.99	0.00	1.26	0.48	1.11	
SET-1	1.83	0.91	1.42	0.95	0.14	0.67	5.40	1.11	0.00	0.58	0.00	0.60	0.25	0.76	1.27	0.87	
SET-2	0.45	0.20	0.35	0.14	0.04	0.11	1.30	0.25	0.00	0.19	0.00	0.20	0.00	0.25	0.31	0.19	
SWT	0.69	1.52	0.73	1.06	0.04	0.56	0.30	0.92	0.33	0.97	0.00	0.99	0.00	1.26	0.49	1.11	

[1] Entries represent the trackline segment value from Potomac Management Group (2003) in units of lb per acre for discharge and unitless numbers for relative impact divided by the average for entire Great Lakes sweepings type.

= Substantial Relative Sweepings Discharge or Potential Impact
= Greater than Average Sweepings Discharge or Potential Impact
= Alternative Trackline Segment for Sweepings Deposition Investigation
= Trackline Segment Targeted for Sweepings Deposition Investigation

Table 3. Schedule for Completion and Assets Required

Lake	Type Vessel	Start Date	End Date	31-Jul	7-Aug	14-Aug	21-Aug	28-Aug	4-Sep	11-Sep	18-Sep	25-Sep	2-Oct
Erie	20+ ft for bottom profiling	14-Aug-06	23-Aug-06										
Huron	20+ ft for bottom profiling	24-Aug-06	30-Aug-06										
Michigan	20+ ft for bottom profiling	1-Sep-06	7-Sep-06										
Superior	20+ ft for bottom profiling	8-Sep-06	18-Sep-06										
Erie	A frame with 2 ton lift	24-Aug-06	28-Aug-06										
Huron	A frame with 2 ton lift	31-Aug-06	4-Sep-06										
Michigan	A frame with 2 ton lift	8-Sep-06	13-Sep-06										
Superior	A frame with 2 ton lift	19-Sep-06	26-Sep-06										

Figures

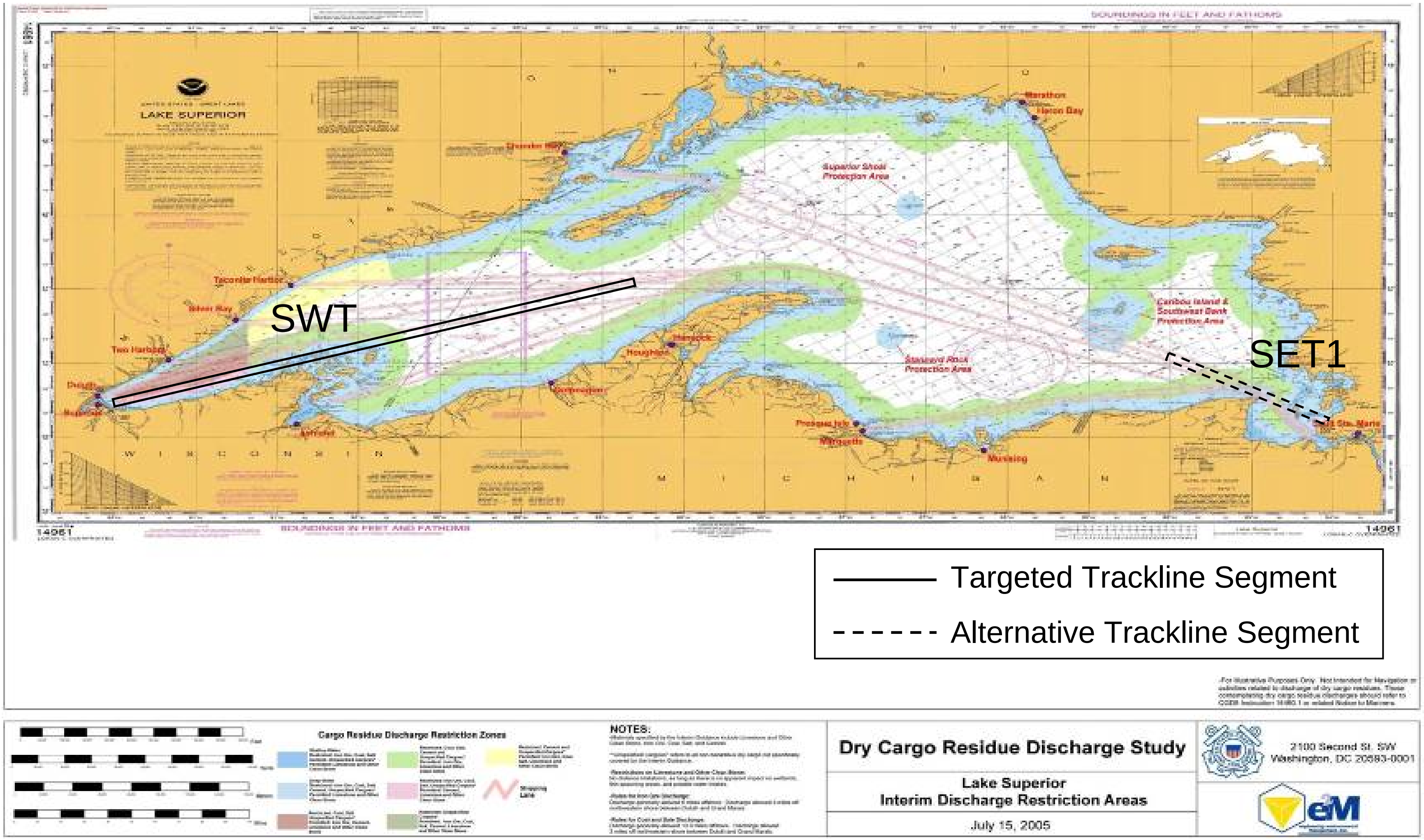

Figure 1 (Modified from USCG 2006). Approximate Locations of Selected Tracklines in Lake Superior

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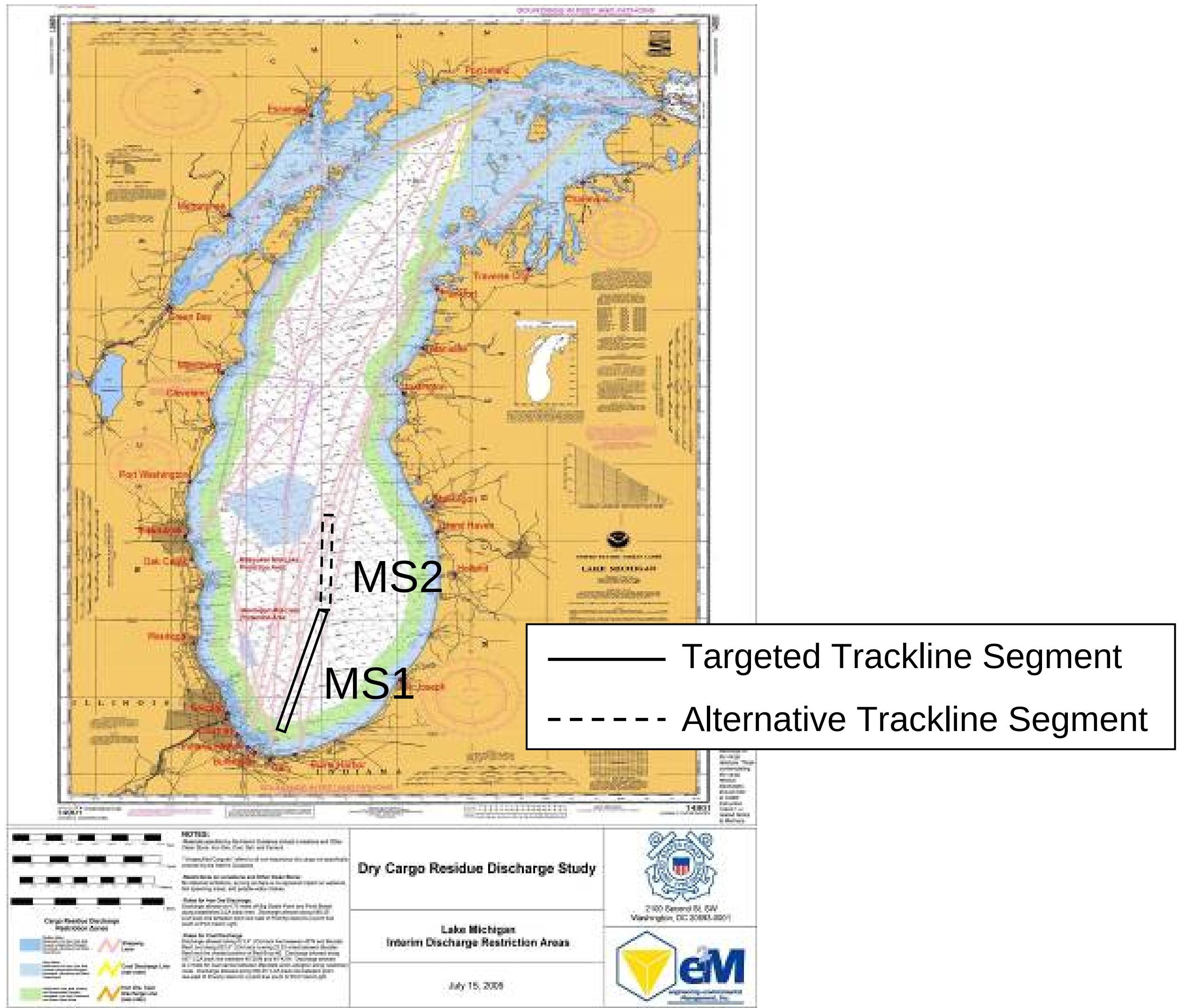

Figure 2 (Modified from USCG 2006). Approximate Locations of Selected Tracklines in Lake Michigan

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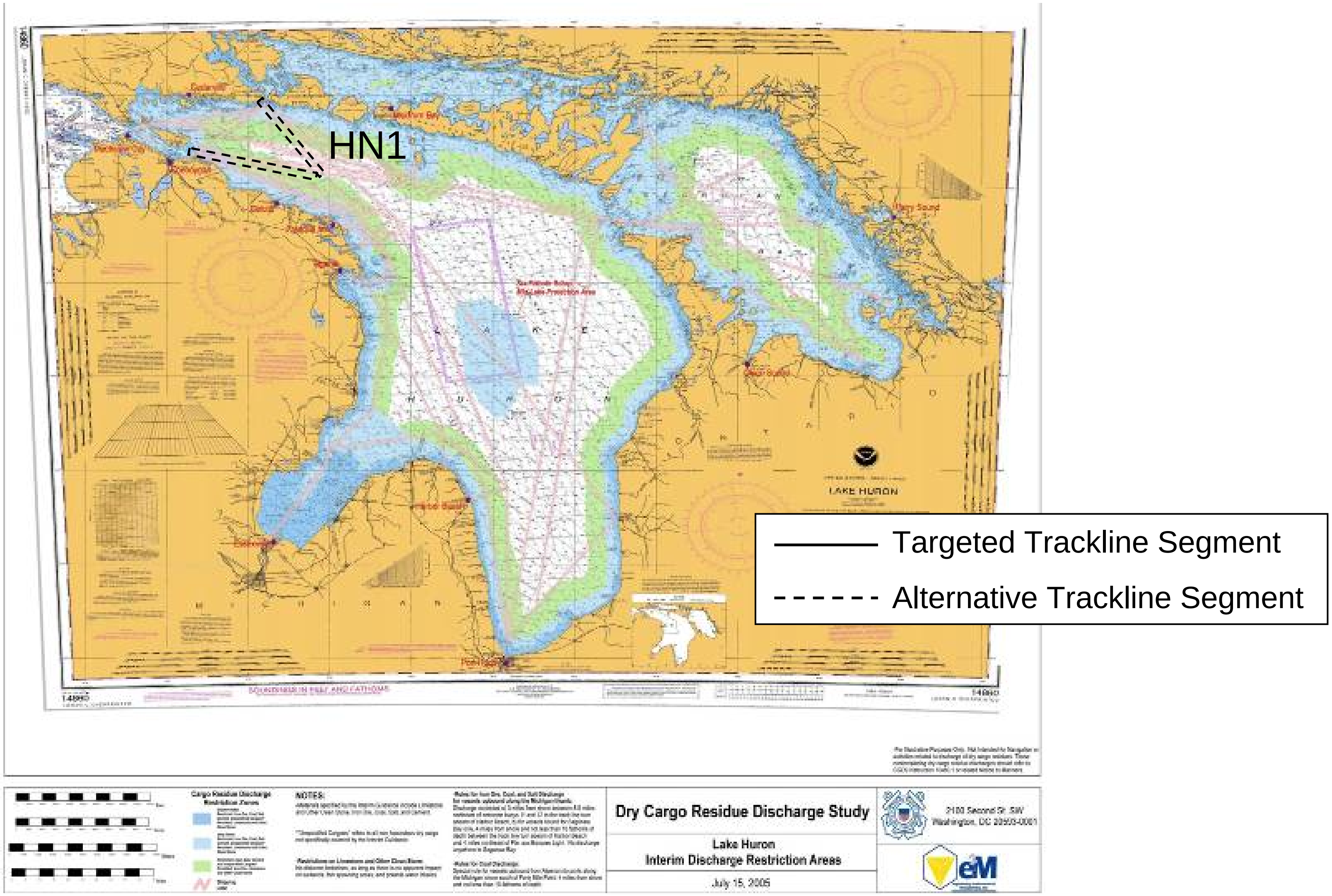

Figure 3 (Modified from USCG 2006). Approximate Locations of Selected Tracklines in Lake Huron

Scientific Plan for Dry Cargo Sweepings Impact Analysis

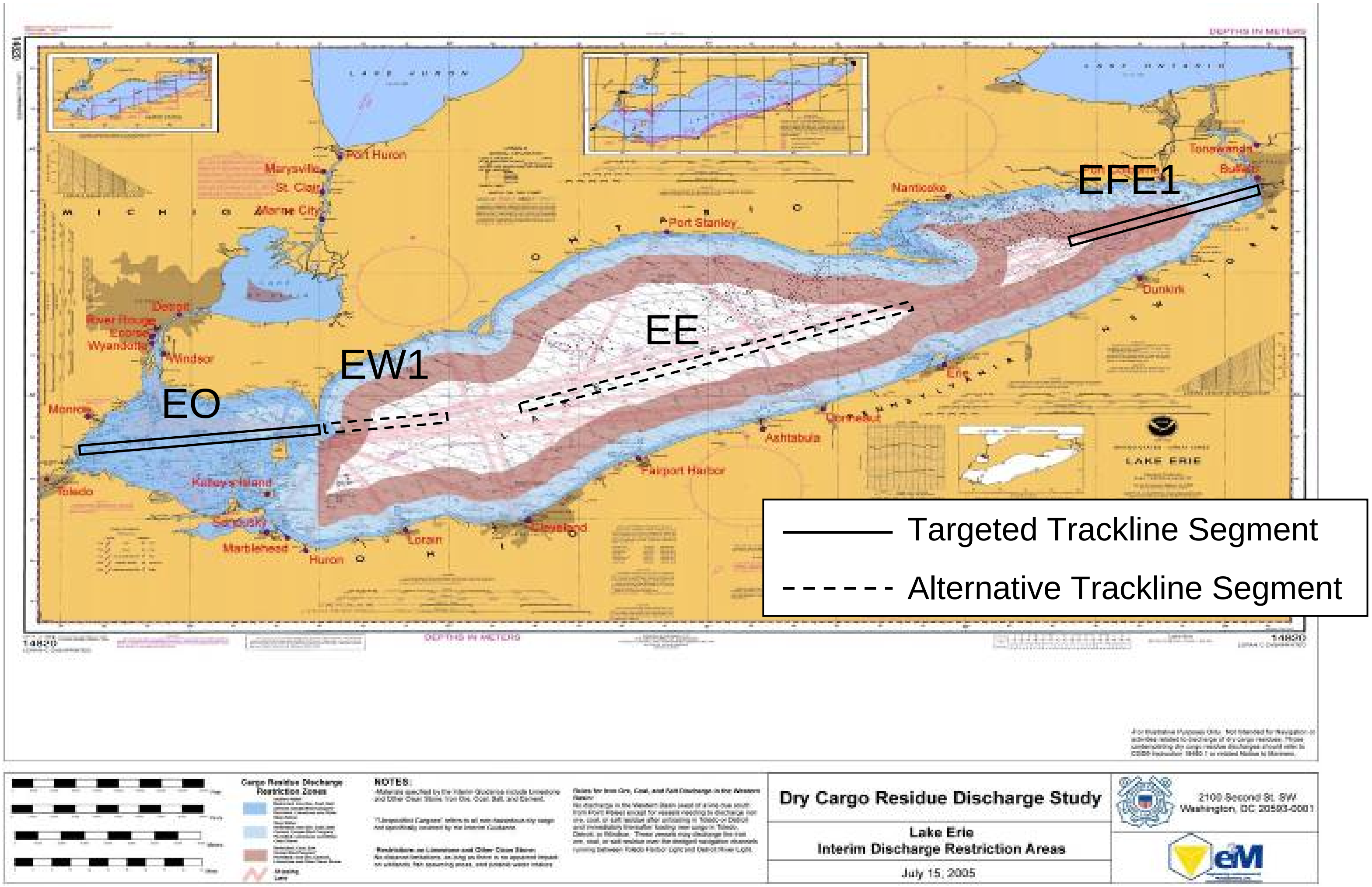

Figure 4 (Modified from USCG 2006). Approximate Locations of Selected Tracklines in Lake Erie

Scientific Plan for Dry Cargo Sweepings Impact Analysis

ID	Task Name	Duration	Start	Finish
1	Collect Sweepings	5 days	Fri 8/4/06	Thu 8/10/06
2	**Bottom Profile Reconnaissance**	**25 days**	**Mon 8/14/06**	**Wed 9/13/06**
3	Erie	5 days	Mon 8/14/06	Fri 8/18/06
4	Huron	4 days	Thu 8/24/06	Mon 8/28/06
5	Michigan	3 days	Fri 9/1/06	Tue 9/5/06
6	Superior	4 days	Fri 9/8/06	Wed 9/13/06
7	**Detailed Bottom Profiling**	**22 days**	**Mon 8/21/06**	**Mon 9/18/06**
8	Erie	3 days	Mon 8/21/06	Wed 8/23/06
9	Huron	2 days	Tue 8/29/06	Wed 8/30/06
10	Michigan	2 days	Wed 9/6/06	Thu 9/7/06
11	Superior	3 days	Thu 9/14/06	Mon 9/18/06
12	**Sediment and Epibenthic Collection**	**25 days**	**Thu 8/24/06**	**Tue 9/26/06**
13	Erie	4 days	Thu 8/24/06	Mon 8/28/06
14	Huron	3 days	Thu 8/31/06	Mon 9/4/06
15	Michigan	4 days	Fri 9/8/06	Wed 9/13/06
16	Superior	6 days	Tue 9/19/06	Tue 9/26/06
17	**Water Column Sample Collection**	**20 days**	**Thu 8/24/06**	**Tue 9/19/06**
18	Erie	1 day	Thu 8/24/06	Thu 8/24/06
19	Huron	1 day	Thu 8/31/06	Thu 8/31/06
20	Michigan	1 day	Fri 9/8/06	Fri 9/8/06
21	Superior	1 day	Tue 9/19/06	Tue 9/19/06
22	Collect Sediment for Colonization	2 days	Mon 9/4/06	Tue 9/5/06
23	Deploy Colonization Trays	3 days	Mon 9/18/06	Wed 9/20/06
24	Retrieve Colonization Trays (Spring 2007)	0 days	Mon 9/25/06	Mon 9/25/06
25	Supplemental Data Collection (Spring 2007)	0 days	Mon 9/25/06	Mon 9/25/06

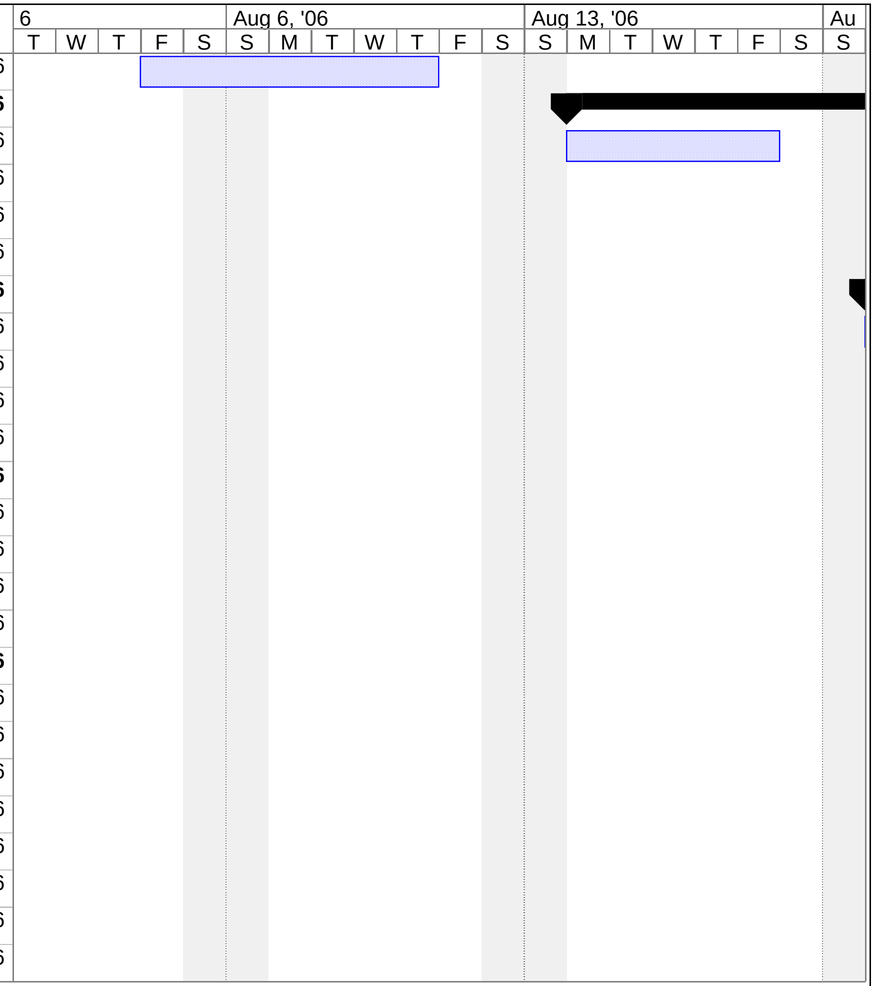

Figure 5. Field Schedule

Task		Milestone		External Tasks	
Split		Summary		External Milestone	
Progress		Project Summary		Deadline	

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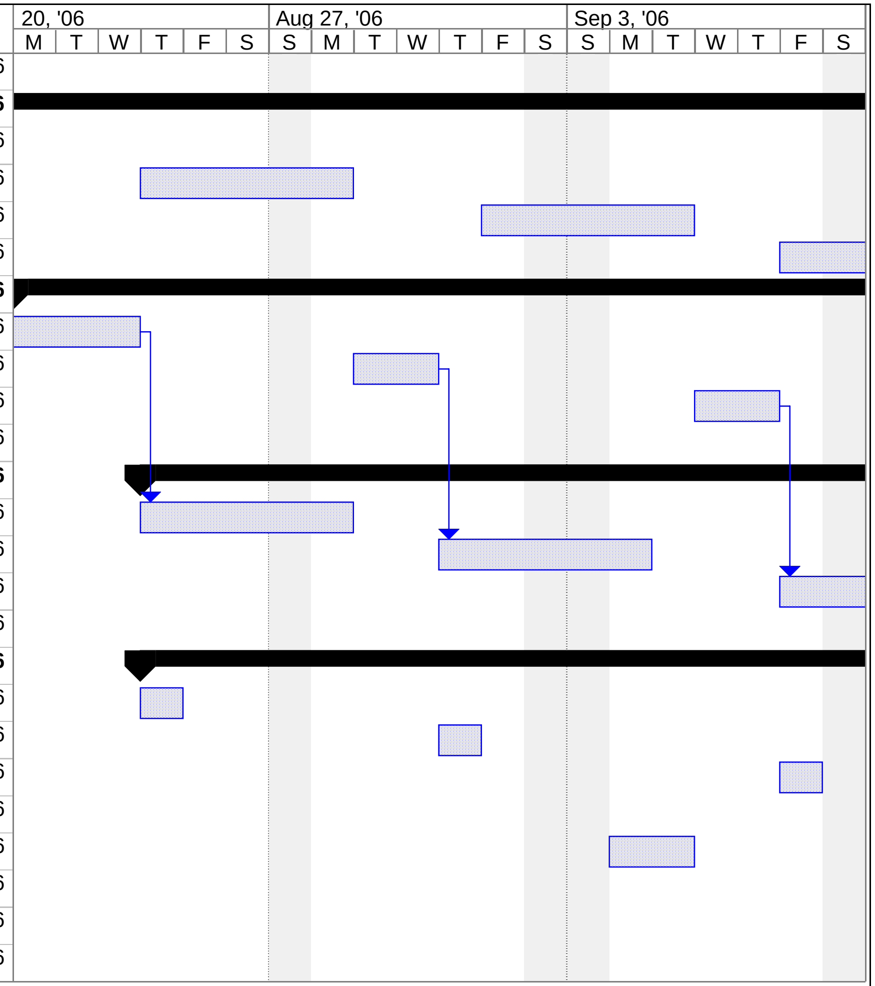

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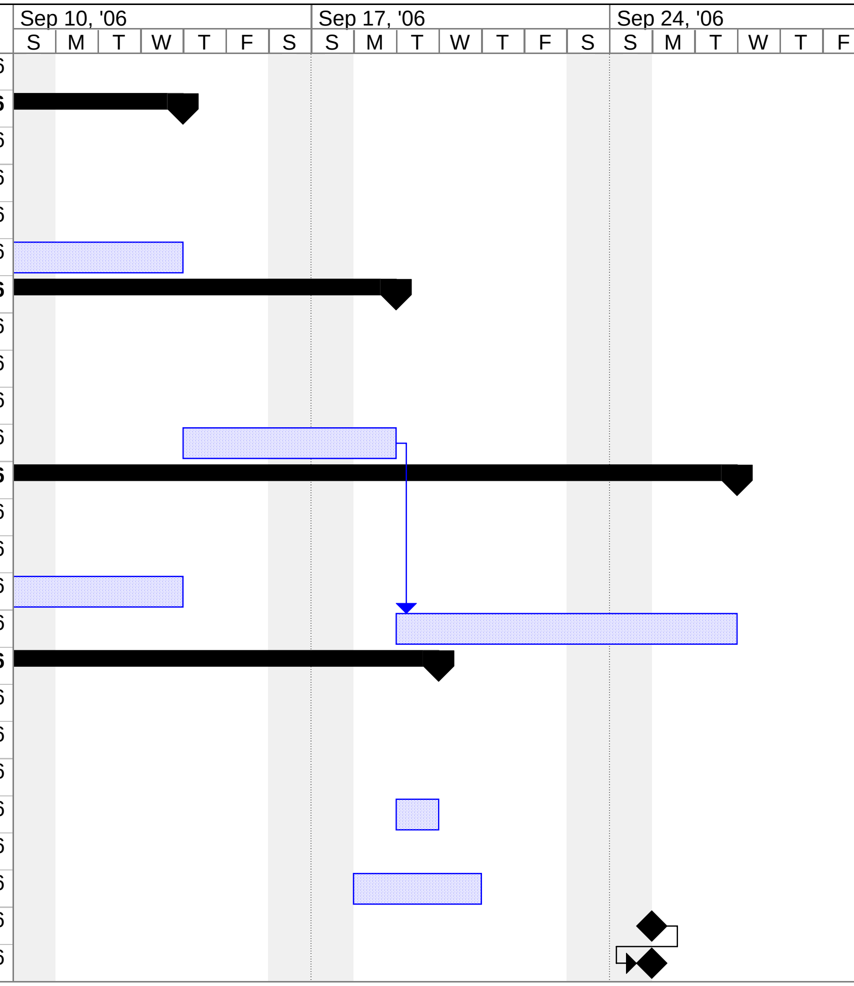

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